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Indian Standard

SPECIFICATION FOR FLEXIBLE INSULATING SLEEVING

PART 2 METHODS OF TEST

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
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Indian Standard

SPECIFICATION FOR FLEXIBLE INSULATING SLEEVING

PART 2 METHODS OF TEST

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Indian Standard

SPECIFICATION FOR FLEXIBLE INSULATING SLEEVING

PART 2 METHODS OF TEST

0. FOREWORD

0.1 This Indian Standard (Part 2) was adopted by the Indian Standards Institution on 22 December 1986, after the draft finalized by the Solid Electrical Insulating Materials Sectional Committee had been approved by the Electrotechnical Division Council.

0.2 It is intended to bring out a series of Indian Standards on flexible insulating sleevings. This series will cover the following in various parts:

a) Part 1 Definitions and general requirements,

b) Part 2 Methods of test, and

c) Part 3 Specifications for indivdual types of sleeving.

0.3 This standard (Part 2) covers the methods of test for flexible insulating sleeving including heat shrinkable sleeving intended primarily for insulating electrical conductors and connections of electrical apparatus.

0.4 The tests specified are designed to control the quality of the sleeving but it is recognized that they do not completely establish the suitability of sleeving for impregnation or encapsulation processes or for other specialized applications. Where necessary, the test requirements in this test will require to be supplemented by appropriate impregnation or compatibility tests to suit the individual circumstances.

0.5 In the preparation of this standard, assistance has been derived from the following:

ISO/R 182 - 1970 (E) 'Determination of the thermal stability of polyvinyl chloride and related copolymers and their compounds by splitting off of hydrogen chloride', issued by the International Organization for Standardization.

ISO/1431/1 'Rubber, vulcanized — Resistance to ozone cracking — Part 1 Static strain test', issued by the International Organization for Standardization.

IEC Pub 684-2 (1984) 'Specification for flexible insulating sleeving; Part 2 Methods of test', issued by the International Electrotechnical Commission.

BS : 2848 (1973) 'Specification for flexible insulating sleeving for electrical purposes', issued by the British Standards Institution.

0.6 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard (Part 2) covers methods of test for flexible insulating sleeving including heat shrinkable sleeving.

2. GENERAL TESTS CONDITIONS

2.1 Unless otherwise specified all tests shall be carried out within a range of 15 to 35°C and a relative humidity range of 45 to 75 percent. Before measurements are made, the specimens shall be preconditioned under these atmospheric conditions for a time sufficient to allow the sleeving to reach stability. When heating at elevated temperature is specified for a test procedure, the specimen shall be maintained in a uniformly heated for the prescribed period.

3. MEASUREMENT OF BORE AND WALL THICKNESS

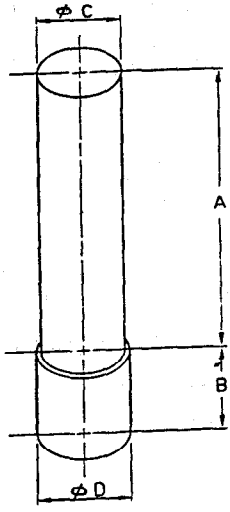
3.0 Suitable methods are given in **3.1**, **3.2** and **3.3**.

3.1 Bore

3.1.1 The bore shall be determined with a plug gauge of length at least three times the bore diameter or 20 mm whichever is the greater. The gauge shall enter the bore without the use of undue pressure. A lubricant in powder form will assist when some types of sleeving are being measured.

3.1.2 An alternative method for measurement of bore of textile sleevings is to use gauges, such as shown in Fig. 1 having the diameter *C* increasing in steps of 0·01 mm.

*Rules for rounding off numerical values (*revised*).



All dimensions in millimetres.

	ϕC	A	B	ϕD
0·5	a/to 2·99	20	12	8
3	a/to 3·99	20	12	8
4	a/to 6·99	20	12	10
7	a/to 10	30	12	12
10	a/to 15	30	15	15
15	a/to 17·99	60	18	18
18	a/to 20	60	18	20

Diameter *C* increases in increments of 0·01 mm.

FIG. 1 WEIGHTED GAUGES FOR MEASURING BORE OF TEXTILE SLEEVING

To determine the bore of textile sleeving a guage of the dimensions shown in Fig. 1 is inserted into a specimen of sleeving longer than dimension *A*. The sleeving is held vertically with the gauge at the bottom and the point of support sufficiently above the end of the gauge to avoid pressing the specimen on to it.

If the gauge falls out freely, the gauge with the next larger diameter is tried, and so on until a gauge is found which just fails to fall out freely.

The bore of the specimen is the diameter of the largest gauge to fall out freely.

3.2 Wall Thickness — A plug gauge or mandrel shall be inserted so that it enters freely but has a diameter not less than 80 percent of the bore.

The overall dimension shall then be measured using a micrometer having flat anvils of approximately 6 mm diameter. In making this measurement the pressure applied by the micrometer shall be just sufficient to close the sleeving on to inserted plug gauge or mandrel. For heat shrinkable sleeving the measurement is made after unrestricted recovery. The wall thickness shall be calculated by halving the difference between the plug gauge or mandrel diameter and the overall dimension. The result shall be reported as the wall thickness.

3.3 Minimum and Maximum Wall Thickness — This part does not give mandatory methods for making the measurment. For heat shrinkable sleeving the measurement shall be made after unrestricted recovery.

NOTE — The following methods of measurement have proved suitable:

a) Optical profile projector,

b) Optical comparator, and

c) A suitable micrometer.

4. DENSITY

4.1 Any method may be used which can ensure an accuracy of 0·01 g/cm^3 at 27 $\pm$ 2°C.

5. RESISTANCE TO SPLITTING AFTER HEATING

5.1 Number of Test Specimens — Three specimens shall be tested.

5.2 Form of Test Specimen — Three specimens shall be produced by cutting rings whose cut length equals the wall thickness. Precautions shall be taken to ensure that the cut is clean since imperfections can affect the result.

5.3 Procedure — The specimens shall be tested using a mandrel tapered sufficiently at one end to enter the bore. The specimens shall be maintained for a period of 168 $\pm$ 2 h at a temperature of 70 $\pm$ 2°C or such other temperature specified in Part 3, and then allowed to cool to 27 $\pm$ 5°C. They shall then be rolled up the mandrel so that they are extended by an amount equal to the percentage of nominal bore diameter specified in Part 3. The specimens shall be kept in that position and at a temperature 27 $\pm$ 5°C for 24 $\pm$ 1 h and then examined for signs of splitting when examined under diffused light.

6. RESISTANCE TO HEAT

6.1 A length of approximately 75 mm of sleeving shall be heated for 4 h$\pm$10 min in an oven at the temperature specified in Part 3. The sleeving

shall be allowed to cool to room temperature and then examined for any signs of dripping, cracking, flowing. In addition, when so specified in Part 3, the specimen shall be tested for elongation at break in accordance with **19.** In this case the specimen subjected to heating shall be of the dimensions required for the test for elongation.

7. RESISTANCE TO SOLDERING HEAT

7.1 Number of Test Specimens — Three specimens shall be tested.

7.2 Form of Test Specimen — 60 mm of sleeving shall be used and approximately 150 mm length of tinned copper wire, of diameter such that it is a sliding fit on the sleeving.

The wire shall be bent through 90° at its middle point round a mandrel of diameter three times the nominal bore of the sleeving.

The sleeving shall be slipped over the wire and worked round the bend so that it covers a length of the straight part of the wire which will be vertical during the test equal to 1·5 times the nominal bore of the sleeving but with a minimum length of 1 mm (*see* Fig. 2).

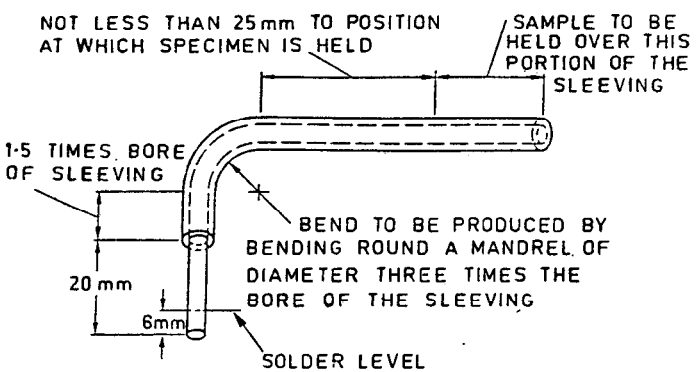


FIG. 2 SPECIMEN FOR TEST FOR RESISTANCE TO SOLDERING HEAT

The wire shall be cut off on the part to be vertical during the test at the end of the sleeving. Not less than 5 min after the wire has been bent, a high grade flux consisting of 25 percent non-activated resin and 2-propanol (isopropanol) or ethyl alcohol shall be applied to the lower 6 mm of the protruding part of the wire.

7.3 Procedure — With the sleeving at a temperature of 27 ± 5°C, the test shall be started within 60 min of the application of the flux. The horizontal part shall be held at the end at least 25 mm away from the bend. The vertical portion shall be immersed in the centre of a bath of molten solder so that 6 mm of the wire is immersed; a convenient way to achieve this is to mark the wire beforehand. The wire shall be held in this position for 15 ± 1 seconds or as specified in Part 3. The solder bath shall be not less than 25 mm in diameter and 12 mm deep and the temperature of the solder shall be maintained at 260 ± 5°C during the test. To pass the test, no specimen shall split or widen considerably, slight melting being permissible (*see* Fig. 3).

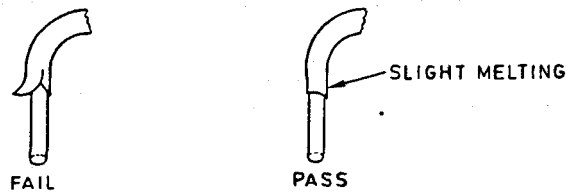


FIG. 3 EXAMPLES OF SLEEVING AFTER BEING SUBJECTED TO TEST FOR RESISTANCE TO SOLDERING HEAT

8. LOSS IN MASS ON HEATING OF UNCOATED TEXTILE GLASS SLEEVING

8.1 Number and Mass of Test Specimens — Three specimens shall be tested, each consisting of a sufficient length to provide 5 ± 1 g.

8.2 Procedure — The specimens shall be conditioned by heating at 105°C ± 2°C for one hour and then allowed to cool in a desiccator to room temperature. They shall then be weighed to the nearest of 0·000 2 g (m_1) then heated in a ventilated furnace at 600 ± 10°C for 60 to 75 min. After cooling in a desiccator to room temperature, the specimens shall be re-weighed (m_2).

8.3 Result — The percentage loss in mass of each test shall be calculated as:

$$\frac{m_1 - m_2}{m_1} \times 100$$

The percentage loss in mass on heating is the central value of the three determinations, the other two values are reported.

9. LONGITUDINAL CHANGE

9.1 Number of Test Specimens — Three specimens shall be tested.

9.2 Form of Test Specimen — A specimen of sleeving 100 mm long cut clearly at right angles to its length and measured to within an accuracy of 0·5 mm.

9.3 Procedure — The specimen shall be supported horizontally on a medium on which it can recover freely. The supported specimen shall be maintained in an oven for the time and temperature specified in Part 3.

The sleeving shall be allowed to cool to room temperature and then re-measured.

9.4 Result — The result of each determination shall be expressed as the percentage change calculated on the original length.

The test result is the central value of the three determinations, the other two values are reported.

10. RESISTANCE TO PRESSURE AT ELEVATED TEMPERATURE

10.1 Number of Test Specimens — Three specimens shall be tested.

The tests shall be carried out not less than 16 h after the extrusion of the sleeving.

10.2 Form of Test Specimen — The test specimen shall be formed by slitting the sleeving along its length and then cutting from the sleeving a section approximately 10 mm × 5 mm (or the full circumference of the sleeving if this is less than 5 mm) so that the long axis of the specimen is parallel to the length of the sleeving.

10.3 Apparatus — The apparatus consists of an instrument capable of measurement to ±0·01 mm with a rectangular indentor blade with an edge 0·70 mm ± 0·01 mm which applied a load to the specimen of 1·2 N ± 0·05 N unless otherwise specified in Part 3. The specimen is placed on a metal mandrel 6·00 ± 0·1 mm in diameter which is supported on a V block. The essential features of this assembly are shown in Fig. 4.

The assembly shall be placed in a uniformly heated air oven maintained at 110 ± 2°C during the heating period unless another temperature is specified in Part 3. To minimize vibration a gravity-circulated oven mounted on suitable damping pads shall be used.

10.4 Procedure — The wall thickness of the test specimen shall be measured by the method of **3.2** except that the plug gauge and sleeving sample therein shall be replaced by the test specimen resting on the mandrel. The wall

thickness shall be the measured difference between the mandrel diameter and the overall dimensions.

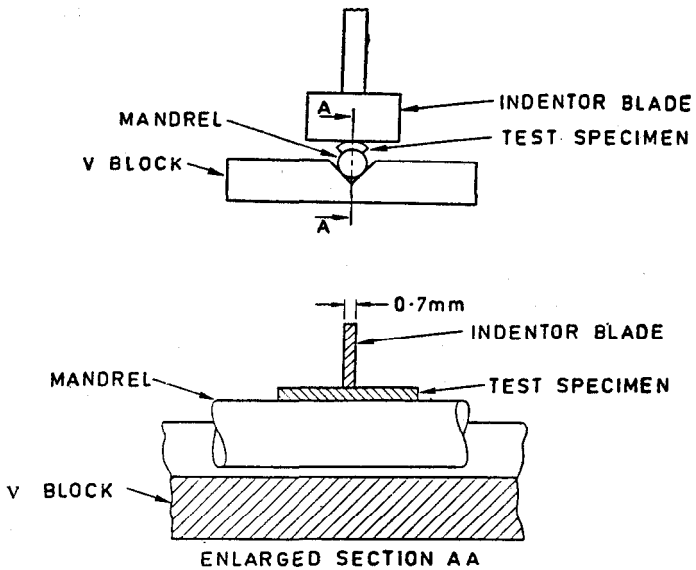


FIG. 4 ARRANGEMENT FOR THE TEST FOR RESISTANCE TO PRESSURE AT ELEVATED TEMPERATURE

The assembly with mandrel but without the test specimen shall be conditioned for at least two hours before the test in the oven at 110 $\pm$ 2°C unless another temperature is specified in Part 3.

The indentor blade shall be raised, the test specimen placed on the mandrel with its long axis parallel to the mandrel and the indentor gently lowered on to the surface of the test specimen.

The assembly and test specimen shall then remain in the oven at the specified temperature for 60 $\pm$ 5 min.

The position of the indentor shall then be recorded. Remove the specimen, allow the indentor to rest directly on the mandrel and again record the position. Subtract the difference between these two readings from the original measured wall thickness to give the indentation. Difference between any two of the three values for the position of the indentor resting directly on the mandrel shall not be more than 0·02 mm.

10.5 Result

The indentation of the specimen shall be expressed as a percentage of the initial wall thickness.

The percentage indentation shall be taken as the central value of the three determinations, the other two values are reported.

11. THERMAL STABILITY OF PVC SLEEVING

11.1 Principle — This method determines the time taken for hydrogen chloride to be evolved from polyvinyl chloride (PVC), its copolymers or compounds or products based on them, when heated.

The evaluation of hydrogen chloride is detected either by the use of Congo red paper (Method A) or by the change in *p*H of a potassium chloride solution contained in a measuring cell (Method B).

11.2 Form of Test Specimen

a) *Method A* — The specimen must be sufficient to fill two of the specified test tubes to a depth of 50 mm and is formed by cutting the sleeving into pieces of maximum dimension 6 mm, slitting where necessary. The pieces of sleeving must not be deliberately compacted in the test tubes.

b) *Method B* — To prepare specimens, cut pieces of sleeving approximately 5 to 6 mm^2 in size and weigh 1·0 g into each test tube.

11.3 Procedure — The test shall be carried out in accordance with either method A or Method B as given in Appendix A. The appropriate section of Part 3 will specify which test is to be used, the test temperature, and in the case of Method B, if a moving gas medium other than air is to be employed.

12. VOLATILE CONTENT OF SILICONE SLEEVING

12.1 Number and Mass of Test Specimen — Three specimens shall be tested, each consisting of a sufficient length to provide 10 $\pm$ 1 g.

12.2 Procedure — The specimens shall be weighed to the nearest 0·01 g (m_1) and then heated in a ventilated oven at 150 $\pm$ 2°C for 4 $\pm$ 1 h. A convenient way to achieve this is to suspend the test pieces over a wire that is thermally insulated from the metalwork of the oven.

After cooling in a desiccator, the specimens shall be reweighed (m_2).

12.3 Result — The percentage loss in mass of each test specimen shall be calculated as:

$$\frac{m_1 - m_2}{m_1} \times 100$$

The result is the central value of the three determinations, the other two values are reported.

13. BENDING AFTER HEATING

13.1 Number of Test Specimens — Three specimens shall be tested each of length sufficient to wind conveniently round a mandrel of the size specified in Part 3 for the sleeving under test.

13.2 Form of Test Specimen — When the nominal bore does not exceed 2 mm, a length of wire which is a sliding fit in the sleeving shall be inserted in the bore of the specimen.

When the nominal bore exceeds 2 mm but does not exceed 15 mm (or other value specified in Part 3 for a particular type of sleeving) the specimen shall be filled by any means suitable (for example, a number of wires) to prevent undue collapse of the sleeving during winding.

When the nominal bore exceeds 15 mm (or other value specified in Part 3 for a particular type of sleeving) the specimen shall consist of a strip of sleeving 6 mm wind cut parallel to the longitudinal axis of the sleeving.

13.3 Procedure — The specimen, filled when so required by the previous paragraph, shall be suspended for 48 $\pm$ 1 hour uniformly heated air oven maintained at the temperature specified in Part 3. It shall then be removed from the oven and allowed to cool to room temperature.

It shall then be wound without jerking for one complete turn in a close helix round a mandrel of the diameter specified in Part 3. For cut strips the inside surface shall be in contact with mandrel. The time to achieve one complete turn shall be not greater than 5 seconds. The specimen shall be held in this position for five minutes.

It shall then be visually examined without magnification with specimen still on the mandrel for signs of cracking, detachment of coating, delaminations or change of colour.

Detection of cracking in sleeving up to 15 mm bore by application of voltage using a method given in **21** may be used if specified in Part 3.

14. BENDING AT LOW TEMPERATURE

14.1 Number and Form of Test Specimens — The number and form of test specimens shall be as in **13** except that when the nominal bore exceeds 8 mm (instead of 15 mm) the specimen shall consist of a strip of sleeving 6 mm wide cut parallel to the longitudinal axis of the sleeving.

Alternatively, where so specified in Part 3 specimens of nominal bore up to and including 8 mm shall be tested unfilled.

14.2 Procedure — The specimen, filled when so required by the previous paragraph, shall be suspended for 60 $\pm$ 10 minutes in a chamber maintained at the temperature specified in Part 3 and, while still at the temperature, shall be wound without jerking for one complete turn in a close helix round a mandrel at the same temperature and having the diameter specified in Part 3. For cut strips, the inside surface shall be in contact with the mandrel. The time to achieve one complete turn shall be not greater than 5 seconds. The specimen shall be held in this position and at the low temperature for five minutes. It shall then be allowed to regain room temperature.

The specimens shall then be visually examined without magnification while still on the mandrel for signs of cracking, detachment of varnish or delamination.

15. BRITTLENESS TEMPERATURE

15.1 The test is made in accordance with IS : 8543* using specimens prepared as follows:

For sleeving of nominal bore up to 4 mm diameter, specimens shall be cut in full section 40 mm long. For sleeving of bore larger than 4 mm, specimens shall be 6 mm wide and 40 mm long, with the longer dimension parallel to the longitudinal axis. The strip specimens shall be so mounted that the hammer strikes the convex side of the specimen.

16. DIMENSIONAL STABILITY ON STORAGE (APPLICABLE TO HEAT SHRINKABLE SLEEVING ONLY)

16.1 Number and Form of Test Specimens — Three specimens shall be tested each approximately 100 mm long.

16.2 Procedure — The internal diameter of the sleeving shall be measured in the expanded state as delivered. The sleeving shall then be stored in a ventilated oven for 336 $\pm$ 2 h at a temperature of 40 $\pm$ 3°C. It shall then

*Methods of testing plastics (in several parts).

be removed from the oven, allowed to cool to ambient temperature and the internal diameter remeasured.

16.3 Result — The dimensional stability is expressed as the percentage change in diameter on the original diameter and the result is the central value of the three determinations.

17. HYDROLYSIS OF COATING

17.1 Test for Stability of Varnish — Cut each specimen of the sleeving into lengths of 40-50 mm and form into a bundle of a diameter to give a push fit into a 125 mm × 12 mm borosilicate test tube.

17.2 It is essential that 'Heavy' wall thickness test tubes are used for this test to minimize the risk of explosion and injury to personnel. As a further safety precaution it is recommended that the test tubes are screened from the observer.

17.3 Where the size of sleeving demands, specimens may be cut along their length to enable them to be rolled up before insertion in the test tube.

17.4 Push the sleeving to the bottom of the test tube, and add 2 cm^3 of distilled water.

17.5 Then insert a short length of tinned copper wire, of approximately 0·60 mm diameter, the end nearest to the sleeving being bent at right angles into a somewhat circular shape. The length of wire shall be such that it is totally within the test tube after sealing, with the formed end above the water level when the tube is inverted. The wire acts as a stop to prevent the sleeving from slipping down into the water.

17.6 Then seal the end of the test tube. This is done conveniently by drawing it out in a flame. Hold the test tube vertically, with the sealed end downwards, and maintain at 100 ± 2°C for 72 hours.

17.7 When three specimens of the sleeving are tested in accordance with **17.1** to **17.6** there shall be no sign of the coating running after 72 hours at 100°C.

18. FLEXIBILITY

18.1 Number and Form of Test Specimens — Three specimens shall be tested, each 150 mm in length.

18.2 Conditioning — The test specimen shall be left loose on a flat surface in an ambient temperature of 27 ± 5°C for approximately 24 h. There-

after, the specimen should be handled as little as possible to avoid increase in its temperature.

18.3 Apparatus — Apparatus of the type shown in Fig. 5 shall be used.

A length of textile thread (*see* Note) shall be attached to the mandrel and passed through the sleeving. The specimen shall be attached to the mandrel by a screw clamp as shown in Fig. 5. The mandrel shall be provided with means of rotating it through 270°. The weight shall be attached to the thread. The weight to be attached is specified in Part 3 for the particular type of sleeving relative to the bore size.

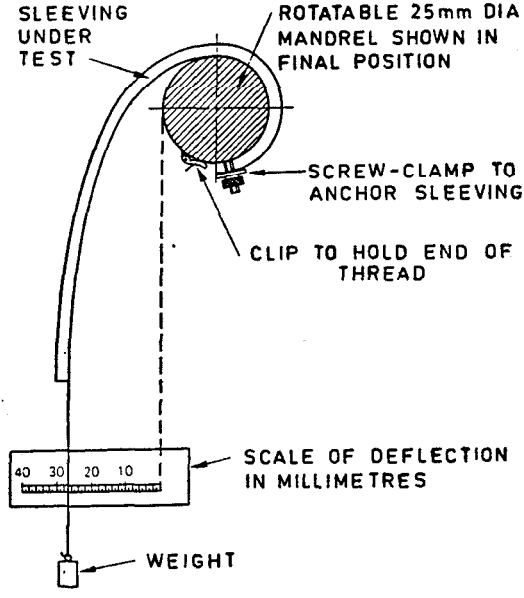


FIG. 5 APPARATUS FOR FLEXIBILITY TEST

NOTE — A polyethylene terephthalate sewing thread is suitable for this purpose but for 0·5 mm bore sleeving it may be necessary to use suction or pull-through to get the thread through the sleeving.

The thread below the sleeving shall pass and almost touch a scale of deflection in mm. A plumbline shall be used to ensure that the zero of the scale is directly below the side of the mandrel.

18.4 Test Temperature — The test shall be made with the sleeving and the apparatus at 27 ± 2°C.

18.5 Procedure — The mandrel shall be rotated so that the screw clamp used to anchor the sleeving is above the zero mark on the deflection scale. The weight shall be applied with the mandrel in this position and the mandrel shall be rotated smoothly immediately through 270° at such a rate that it reaches the position shown in Fig. 5 in about 10 seconds. The deflection shall be recorded 30 ± 5 s after completion of the rotation. If there is any curvature the test shall be carried out with the curvature and not against it. The true deflection is obtained by substracting the wall thickness of the sleeving under test, from the deflection recorded.

NOTE — It may be necessary to use a guide to ensure that the sleeving remains in a vertical plane.

18.6 Result — The result is the central value of the three determinations, the other two values are reported.

19. TENSILE STRENGTH, ELONGATION AT BREAK AND SECANT MODULUS AT 2 PERCENT OR 100 PERCENT ELONGATION

19.0 Specification sheets in Part 3 may stipulate some of the following tests according to the type of sleeving. In some cases more than one of the tests given below can be carried out in the same operation:

a) Tensile strength and elongation at break on full section sleeving,

b) Tensile strength and elongation at break on dumb bell specimens,

c) Tensile strength and elongation at break of uncoated textile glass sleeving,

d) Secant Modulus at 2 percent elongation,

e) Secant Modulus at 100 percent elongation, and

f) Secant Modulus at 100 percent elongation and at elevated temperature.

NOTE — In all these tests appropriate jaws should be used. Spceimens should be protected to avoid failure at the jaws.

19.1 Tensile Strength and Elongation at Break for Full Section Sleeving

19.1.1 *Number of Test Specimens* — Five specimens shall be tested.

19.1.2 *Form of Test Specimen* — The test specimen shall be a length of sleeving sufficient to allow 100 mm between the clamps of the testing machine and shall be marked with two parallel reference lines 50 m apart

approximately mid-way between the jaws. The marking medium shall have not deterimental effect on the material and the marks shall be as narrow as possible. The use of a marker with parallel printing blades is recommended.

19.1.3 *Conditioning* — Unless otherwise specified in Part 3 the test specimen shall be kept in an ambient temperature of 27 ± 2°C for one hour immediately before testing or for such longer time as will enable the specimen to reach a temperature of 27 ± 2°C.

19.1.4 *Test Temperature* — The test shall be made at a temperature of 27 ± 2°C.

19.1.5 *Procedure* — The cross-sectional area of the test specimen shall be calculated from measurements of bore and wall thickness made in accordance with **3**.

The specimen shall be mounted in the tensile test machine in axial alignment with the direction of pull. The jaws shall be separated at the uniform rate specified in Part 3 for a particular material. The range of the testing machine shall be such that the maximum load is between 15 percent and 85 percent of the maximum scale reading.

The distance between the reference lines at break may conveniently be measured by means of a ruler lightly attached to the specimen or by an extensometer.

The maximum load shall be determined to the nearest of 2 percent. The distance between the reference lines at break shall be measured to within 2 mm.

If the test specimen breaks outside the reference line the result shall be discarded and a further test made using another specimen.

19.1.6 *Result* — The tensile strength shall be calculated from the maximum load and the original area of cross-section and the result expressed in MPa.

The elongation at break shall be expressed as a percentage of the original distance between the reference lines, that is:

$$\text{Elongation at break percent} = \frac{L - L_0}{L_0} \times 100$$

where

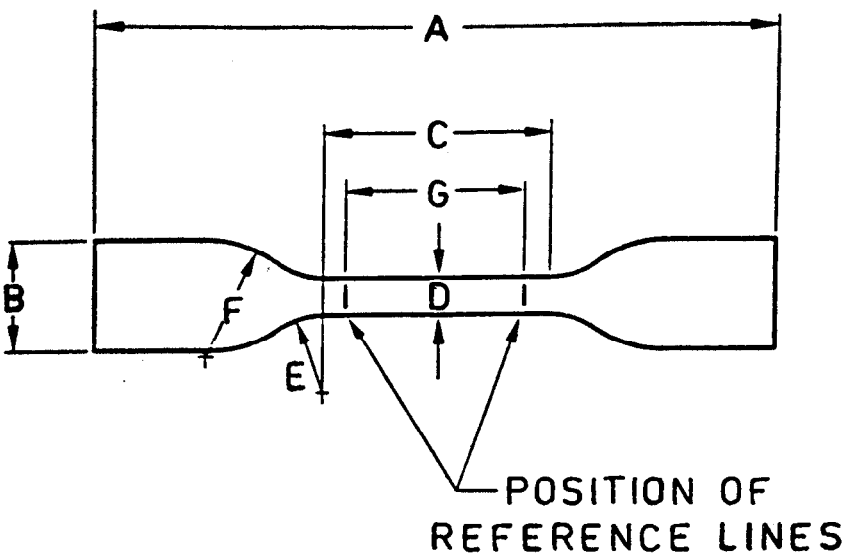
L = measured distance between the two marks on the stretched specimen; and

L_0 = the original distance between the marks.

For tensile strength and elongation at break the test result is the central value of the five determinations of each property. The highest and lowest values are reported.

19.2 Tensile Strength and Elongation at Break on Dumb-Bell Specimens

19.2.1 The test shall be carried out exactly as in **19.1** except: Specimens shall be cut to the dimensions and tolerances given in Fig. 6 with the major axis in the longitudinal direction of the sleeving. The sleeving shall be slit along its length and laid flat on a slightly yielding material having a smooth surface (for example, leather, rubber, or high quality cardboard) on a flat rigid base. The specimen shall be stamped from the sheet of sleeving using a single stroke of a press and a knife edge punch of appropriate form and dimensions.



A	= Minimum overall length	75 mm
B	= Width at ends	12·5 ± 1·0 mm
C	= Length of narrow parallel portion	2·5 ± 1 mm
D	= Width of narrow parallel portion	4·0 ± 0·1 mm
E	= Small radius	8·0 ± 0·5 mm
F	= Large radius	12·5 ± 1·0 mm
G	= Distance between reference lines	< 20 mm

In any one specimen, the thickness of the narrow parallel portion shall nowhere deviate by more than 2% from the mean.

FIG. 6 DUMB-BELL SPECIMEN FOR TENSILE STRENGTH TEST

19.2.2 The width and thickness of the central parallel portion of specimen shall be measured to the nearest 0·01 mm at several points and the mean cross-sectional area determined.

19.2.3 The distance between the reference lines at break shall be measured to within an accuracy of 2 percent.

19.3 Tensile Strength and Elongation at Break of Uncoated Textile Glass Sleeving

19.3.1 The test shall be carried out exactly as in **19.1** except the rate of separation of jaws shall be 25 $\pm$ 5 mm/min.

19.3.2 The cross-sectional area shall be calculated from the product of twice the wall thickness as measured in **3.2**, and the width of a flat tape prepared as follows:

The sleeving is held under a tensile stress of about 10 percent of the breaking stress and lightly pressed between plates to form a tape. The width of this tape can be measured easily if one of the plates has a scale engraved on its edge.

19.4 Secant Modulus at 2 Percent Elongation — The test shall be carried out as in **19.1** except that the reference lines need not be 50 mm apart, and in addition:

a) Only three determinations need be made.

b) For large bore sleeving, specimens are cut as strips 10 $\pm$ 0·25 mm wide of sufficient length to enable the accuracy of measurement specified below.

c) The secant modulus shall be calculated from a determination of the tensile stress necessary to produce in the specimen an extension of 2 percent of the length between reference lines.

d) An extensometer shall be used which will measure the extension to within 2 percent of the extension being measured.

e) An initial tensile force (F) may need to be applied to the specimen for the purpose of straightening it. This force may conveniently be approximately 1 percent of the expected force at 2 percent strain. With this initial force on the specimen the reading of the indicating device on the extensometer shall be noted or the indicating device be set to zero as appropriate.

f) If it is not feasible to carry out the test using the same rate of separation of jaws as in the test for tensile strength then the test for secant modulus shall be carried out separately, using a rate of 0·2 ± 0·05 mm/min for each milimetre between reference lines (for example, 50 mm/min on a 250 mm length between reference lines).

g) The force shall be increased until the increase in extension between the reference lines indicated by the extensometer reaches 2 percent of the distance between the reference lines. The force (F_1) required to produce this extension shall be reported.

h) The secant modulus of the specimen shall be calculated as follows:

$$2 \text{ percent secant modulus} = \frac{F_1 - F}{0{\cdot}02\ A}$$

where

A = initial cross-sectional area of the specimen,

F_1 = force required to produce a 2 percent extension, and

F = force applied to produce the initial (straightening) stress.

A is expressed in square millimetres, F and F_1 are expressed in newtons (N) giving the result in megapascals (MPa).

The secant modulus at 2 percent elongation of the material under test is the central value of the three results, the other two values are also reported.

19.5 Secant Modulus at 100 Percent Elongation — The test shall be carried out as in **19.1** or **19.2** as appropriate and in addition:

a) the load shall be recorded when the distance between the reference lines is increased by 100 percent.

b) the secant modulus at 100 percent elongation of the specimen shall be calculated as follows:

$$100 \text{ percent secant modulus} = \frac{F_2}{A}$$

where

A = initial cross-sectional area of the specimen, and

F_2 = force required to produce a 100 percent extension.

A is expressed in square millimetres, F_2 is expressed in newtons giving the result in megapascals.

The secant modulus at 100 percent elongation of the material under test is the central value of the three results, the other two values are also reported.

19.6 Secant Modulus at 100 Percent and at Elevated Temperature — The test shall be carried out as in **19.5** and at the temperature specified in Part 3.

20. FRAYING RESISTANCE TEST

20.0 Introduction — Fraying of uncoated glass fibre sleeving often occurs as a result of mechanical handling or impact at the cut end of the sleeving, as, for example, in installation processes or in shipping. This test serves to evaluate the resistance of sleeving to fraying by measuring dilation at the cut end after controlled impacts.

20.1 Number and Length of Test Specimens — Three specimens shall be tested, each shall be a 150 mm length of sleeving. Specimens shall be cut using sharp shears (do not guillotine-cut), care being taken to avoid disturbing the end fibres after cutting.

20.2 Procedure — Using a slide projector, project an image of the sleeving on to a screen in such a way that the outside diameter of the image can be measured and so that repeat measurements can be made without altering the value obtained. Measure the outside diameter of the image at a central point on the specimen (remote from the ends). Rotate the sleeving through 90° and repeat the measurement. Average the measurements and record as *d* to the nearest 0·05 mm.

Select a steel rod 350 mm long and of a size sufficiently smaller in diameter than the bore of the sleeving, so as to allow the specimen free vertical fall when mounted thereon.

Slip the specimen on to the rod, with its upper end flush with the upper end of the rod held vertically (*see* Fig. 7). Allow the specimen to fall freely under the influence of gravity against a hard horizontal surface. Repeat this procedure for a total of ten impacts.

Remove the specimen from the rod, being careful not to disturb the impacted end. Using the slide projector as before, measure the image of the flared diameter of the impacted end. Rotate the sleeving through 90° and repeat the measurement. Average the measurements and record as *D* to the nearest 0·05 mm.

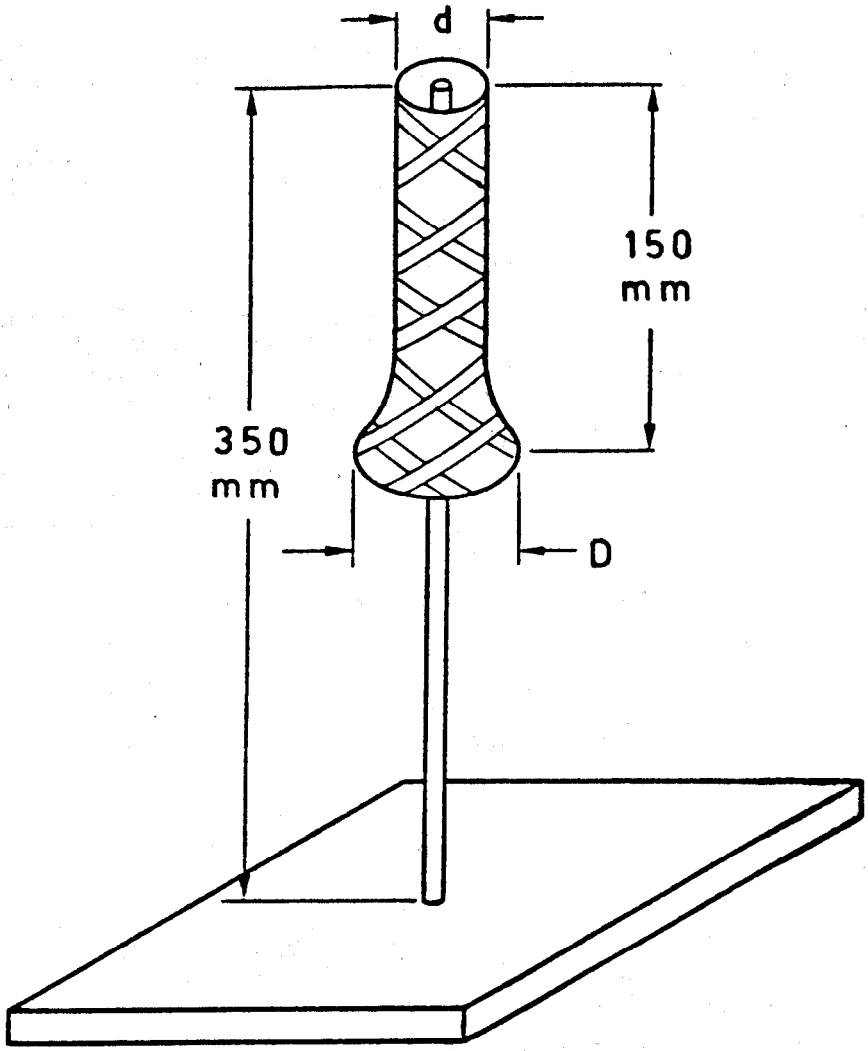


FIG. 7 SKETCH OF FRAY TEST ARRANGEMENT

20.3 Calculation — Calculate the percentage of fray using the following expression:

$$\text{percent of fray} = \frac{D - d}{d} \times 100$$

where

D = average diameter of flared end of impacted specimen, and

d = average outside diameter of sleeving.

20.4 Result — The fraying resistance is the central value of the three determinations of percentage of fray. The other two values are also reported.

21. BREAKDOWN VOLTAGE

21.0 Introduction — Four methods of test are included, three of which use sleeving in full section tested on a mandrel, while the fourth uses slit material tested between flat electrodes.

The breakdown voltage tests are normally made in air, but if flash-over becomes a problem, testing in a suitable insulating liquid may be used.

21.1 Conditioning — In case of doubt or dispute, these tests shall be made on specimens which have been conditioned by free exposure for not less than 24 h to an atmosphere of 65 ± 5 percent relative humidity at a temperature of 27 ± 2°C.

21.2 Shot Bath Test

21.2.1 *Preparation of Sleeving* — A length of approximately 350 mm of sleeving shall be applied over a round conductor to form the test specimen. For small diameter sleevings, the conductor is straight prior to application of the sleeving and both are then bent together into a U shape. For larger diameter sleevings, the conductor may be shaped into a U before the sleeving is applied. The U shape shall have a radius of 25 mm as shown in Fig. 8. The conductor shall be of diameter approximately that of the bore of the sleeving (and not less than 75 percent of it). To avoid damage to the sleeving the conductor shall have all burrs removed.

21.2.2 *Container* — The specimen shall be placed in a container designed to hold the specimen so that 250 mm of its length is immersed in shot. The dimensions of the container are unimportant provided this is achieved. It is convenient to use a container designed so that the shot can be poured over the sleeving by tilting the container; this is especially so when carrying

out repeated tests at elevated temperature. A convenient arrangement is shown in Fig. 8.

21.2.3 *Shot* — The shot shall be 0·75 mm to 2·0 mm in diameter and can be nickel plated or stainless steel but any shot of the required dimensions is suitable, provided it does not damage the sleeving and provides a conducting medium such that breakdown occurs when a voltage of 20 V ac is applied between an electrode inserted in the middle of the shot and the walls of the container.

21.2.4 *Procedure* — The shot shall be poured into the container so that it surrounds the specimen throughout the central 250 mm of its length and separates the specimen from all sides of the container. Care is needed to avoid damage to the specimen by the shot.

The voltage shall be applied between the conductor and the shot.

21.3 Straight Mandrel Test, 25 mm Electrode

21.3.1 *Test Specimen* — The specimen shall be a length of sleeving not less than 100 mm long.

21.3.2 *Electrodes* — The internal electrode shall be a metal mandrel which fits snugly in the sleeving. The outer electrode shall be a strip of metal foil 25 mm wide and not more than 0·025 mm thick applied snugly round the sleeving. The mandrel shall extend beyond the specimen at each end and the distance between the foil electrode and the end of the specimen shall be sufficient to prevent flashover.

21.4 Straight Mandrel Test, 250 mm Electrode

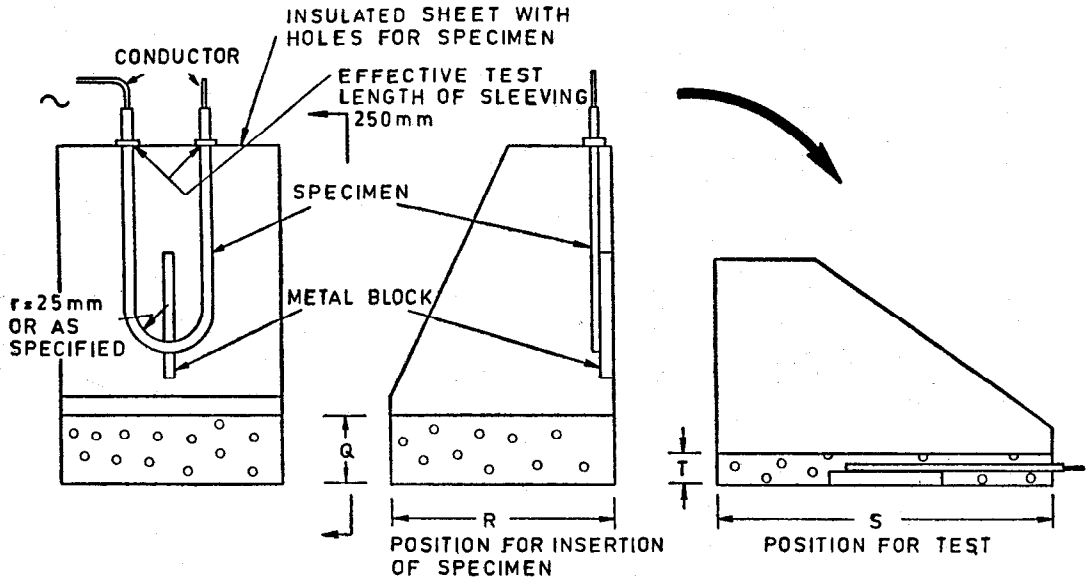
21.4.1 *Test Specimen* — The specimen shall be a length of sleeving not less than 300 mm long.

21.4.2 *Electrodes* — The internal electrode shall be a metal mandrel which fits snugly in the sleeving. The outer electrode shall be 250 mm long, formed from a strip of metal foil not more than 0·025 mm thick, applied snugly round the sleeving. The mandrel shall extend beyond the specimen at each end and the distance between the foil electrode and the end of the specimen shall be sufficient to prevent flashover.

21.5 Test on Cut-out Specimens of Large Size Sleeving

21.5.1 *Test Specimen* — The specimen shall be a strip of sleeving of sufficient size to prevent flashover.

21.5.2 *Electrodes* — The electrodes shall be two metal rods, each 6 mm in diameter, mounted vertically one above the other, so that the specimen is held between the faces of the squared ends of the rods. The upper and



$$Q \times R = S \times T$$

FIG. 8 ARRANGEMENT FOR SHOT BATH ELECTRIC STRENGTH TEST

lower electrodes are to be coaxial. The sharp edges of the squared ends shall be removed to give a radius of approximately 1 mm. The upper electrode shall weigh 50 ± 2 g.

21.6 Application of Voltage — The voltage used shall be in accordance with IS : 2584-1963* and be applied at a rate of increase specified in Part 3.

21.7 Test Conditions

21.7.1 *Number of Tests Specimens* — For the method in **21.2**, **21.4** and **21.5** three specimens shall be tested.

For the method in **21.3**, nine specimens shall be tested.

21.7.2 *Tests at Room Temperature* — The appropriate number of prepared specimens shall be tested. The voltage shall be applied as in **21.6.**

21.7.3 *Tests at Elevatea Temperature* — The appropriate number of prepared specimens shall be tested. The specimens, shot (method of **21.2**) and electrodes shall be placed in an oven and maintained at the temperature specified in Part 3 for 60 ± 5 min. The voltage shall be applied as in **21.6** while the specimen is at the specified temperature.

21.7.4 *Tests After Damp Heat* — Select an appropriate length of sleeving, pre-heat to 40°C to 45°C and then expose for four days to the 'damp-warm' conditions specified in IS : 2260-1973†.

Remove the sleeving from the conditioning chamber, and allow to cool to room temperature in an atmosphere of 75 percent relative humidity, then prepare and test the specimens as described in **21.7.2** within 1 h to 2 h of removal.

21.8 Test Report — The breakdown voltage for each specified testing condition is the central value of the test results for tests under that condition. The highest and lowest values are also reported.

22. INSULATION RESISTANCE

22.1 Conditioning — In case of doubt or dispute, the tests shall be made on specimens which have been conditioned by free exposure for not less than 24 h to an atmosphere of 65 ± 5 percent humidity at a temperature of 27 ± 2°C.

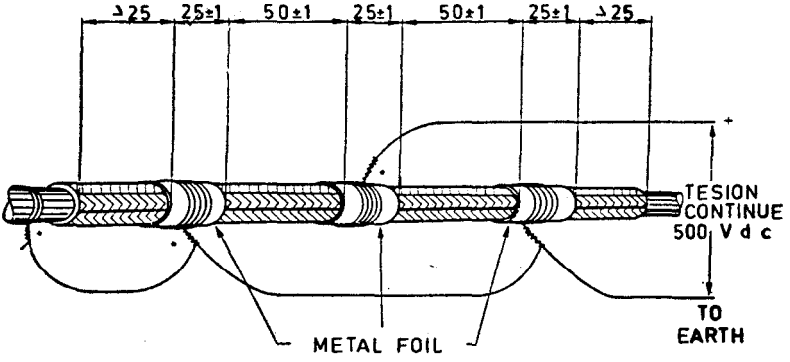
22.2 Form of Test Specimen — A piece of copper wire or tube which is a sliding fit shall be inserted in a sample of the sleeving. Three pieces of metal

*Methods of test for electric strength of solid insulating materials at power frequencies.

†Preconditioning, and testing of solid electrical insulating materials (*first revision*).

foil, each 25 ± 1 mm wide, shall be wrapped round the specimen, one in the middle and one near each end so that two lengths of sleeving, each 50 ± 1 mm long, are left uncovered, as shown in Fig. 9. The two wrappings of metal foil, near to the ends of the specimen, shall be connected to the inserted wire or tube and earthed during the test. Connecting leads shall be attached as shown in Fig. 9.

NOTE — A high conductivity metal paint is a permitted alternative, provided the sleeving is not affected by the solvent in the paint.



*Wires to be Drawn Tight and Soldered at these Points.

All dimensions in milimetres.

FIG. 9 SPECIMEN FOR INSULATION RESISTANCE TEST

22.3 Measurement of Insulation Resistance — A voltage of 500 ± 15 V dc shall be applied to each specimen between the central and outer metal foils. The insulation resistance shall be measured not less than 1 min/or more than 3 min after the application of the voltage.

22.4 Test Conditions

22.4.1 *Number of Test Specimens* — For each of the conditions given below, three specimens shall be tested.

22.4.2 *Tests at Room Temperature* — Specimens shall be prepared as in **22.2** and the insulation resistance measured in accordance with **22.3** at 27 ± 2°C and 65 ± 5 percent relative humidity.

22.4.3 *Tests at Elevated Temperature* — Specimens shall be prepared as in **22.2**. They shall then be placed in an oven and maintained at the temperature specified in Part 3 for 60 ± 5 min. The insulation resistance

shall be measured in accordance with **22.3**, while the specimen is still maintained at the specified temperature.

22.4.4 *Tests After Subjection to Damp Heat Conditions* — Specimens shall be prepared as in **22.2**. They shall then be subjected to four days of damp-warm as specified in IS : 2260-1973* and tested under those conditions.

22.5 Result — The result for each of the conditions specified is the central value of the three determinations, the other two values are also reported.

23. VOLUME RESISTIVITY

23.1 Conditioning — In case of doubt or dispute, the tests shall be made on specimens which have been conditioned by free exposure for not less than 24 h to an atmosphere of 65 ± 5 percent relative humidity at a temperature of 27 ± 2°C.

23.2 Form of Test Specimen — A specimen of sleeving 250 mm long shall be threaded over a copper rod or wires (the inner electrode) the diameter of which shall be smaller than the bore of the sleeving by the amount specified in Part 3.

The outer electrode shall be 200 mm long and of high conductivity metal paint applied to the outside of the sleeving. Guard rings shall be added at each end of the specimen according to the principles of IS : 3396-1979†.

23.3 Measurement of Volume Resistivity — The resistance shall be measured in accordance with IS : 3396-1979† using 500 ± 15 V dc and an electrification time of 1 min.

The volume resistivity ρ in ohm metre (Ω m) shall be calculated according to the following formula:

$$\rho = 1{\cdot}257\ R/\mathrm{In}\ \frac{d + 2s}{d} = 0{\cdot}546\ R/lg\ \frac{d + 2s}{d}$$

where

R = measured resistance in ohms,

d = inner diameter of the sleeving,

*Preconditioning, and testing of solid electrical insulating materials (*first revision*).

†Methods of test for volume and surface resistivities of solid electrical insulating materials.

s = wall thickness of the sleeving,

ln = natural logarithm, and

lg = common (Briggsian) logarithm ($\log_{10}$).

23.4 Test Conditions

23.4.1 *Number of Test Specimens* — For each of the conditions given below, five specimens shall be tested.

23.4.2 *Tests at Room Temperature* — Specimens shall be prepared as in **23.2** and the volume resistivity measured in accordance with **23.3** at 27 ± 2°C and 65 ± 5 percent relative humidity.

23.4.3 *Tests at Elevated Temperature* — Specimens shall be prepared as in **23.2**. They shall then be placed in an oven and maintained at the temperature specified in Part 3 for 60 ± 5 min. The volume resistivity shall be measured in accordance with **23.3** while the specimen is still maintained at the specified temperature.

23.4.4 *Tests After Subjection to Damp Heat Conditions* — Specimens shall be prepared as in **23.2**. They shall then be subjected to four days of damp-warm as specified in IS : 2260-1973* under those conditions.

23.5 Result — The result for each of the conditions specified is the central value of the five determinations, the highest and lowest values are also reported.

24. PERMITTIVITY AND DISSIPATION FACTOR

24.1 Number of Test Specimens — One specimen shall be tested.

24.2 Form of Test Specimen — The specimen shall be a length of sleeving sufficient to accommodate the electrodes specified herein. Heat shrinkable sleeving shall be shrunk on to the mandrel forming the inner electrode according to the directions of the supplier. Before this is done the diameter of the mandrel d_1 shall be determined to the nearest 0·01 mm as the mean of ten measurements made at points uniformly distributed along the length and around the circumference of the mandrel.

24.3 Electrodes — The inner electrode shall be a metal mandrel which provides good contact with the bore and for heat shrinkable sleeving has a diameter equal to the maximum recovered diameter of the sleeving. The outer electrode and guard rings shall be bands of metal foil or suitable conducting paints. When metal foil is used, it shall be applied to the

*Preconditioning, and testing of solid electrical insulating materials (*first revision*).

specimen using the smallest possible quantity of any low-loss grease or liquid. The guard rings shall be 25 mm wide and shall be applied to the sleeving at both ends of the outer electrode with a clearance of approximately 1·5 mm. The length of the outer electrode shall be such that the capacitance can be measured within the region of optimum sensitivity of the bridge. The inner electrode shall extend at least as far as the outer edges of the guard rings.

24.4 Procedure — The temperature of test shall be 27 $\pm$ 2°C. The outer diameter of the specimen d_2 shall be determined after it has been applied to the mandrel and immediately before the capacitance is measured. It shall be determined to the nearest 0·01 mm as the arithmetic mean of ten measurements made at points uniformly distributed along its length and around its circumference.

The measurement of permittivity shall be made with a suitable instrument complying with IS : 4486 - 1967*. The low voltage lead shall be connected to the guarded electrode.

The relative permittivity ϵ_r shall be calculated according to the following formula:

$$\epsilon_r = 18\ C\ In\ (\ d_2/d_1\ )/(\ l + w\ )$$
$$= 41{\cdot}4\ C\ Ig\ (\ d_2/d_1\ )/(\ l + w\ )$$

where

C = measured capacitance, in picofarads;

d_1 = diameter of the mandrel, in millimetres;

d_2 = outer diameter of the specimen, in millimetres;

l = length of the guarded electrode, in millimetres;

w = width of the gaps between the guarded electrode and the guard rings, in millimetres;

In = natural logarithm; and

Ig = common (Briggsian) logarithm ($\log_{10}$).

The dissipation factor is derived from the bridge readings in accordance with IS : 4486 - 1967*.

*Recommended methods for the determination of the permittivity and dielectric dissipation factor of electrical insulating materials at power, audio and radio frequencies including metre wavelengths.

25. RESISTANCE TO TRACKING

25.1 The test shall be carried out in accordance with method A of IS : 9947 - 1981* ambient conditions using specimens as agreed between the purchaser and the supplier.

26. FLAME PROPAGATION TESTS FOR SLEEVING

26.0 Introduction — Two methods (A and B) with many common features are described. The tests are of different severity and it will be stated in Part 3 which should be applied to a particular type or grade of sleeving.

26.1 Test Specimens — Three specimens shall be tested.

26.1.1 *For Method A* — Applicable to sleevings up to and including 10 mm bore only : For non-heat shrinkable sleeving a length of approximately 450 mm shall be centred on a 530 mm straight length of a steel rod which is a sliding fit in the sleeving.

For heat shrinkable sleeving the specimen shall be as above, but the sleeving shall be recovered on to a steel rod which shall have the same diameter as the specified recovered diameter of the sleeving.

NOTE — For sleeving over 10 mm bore consideration is being given to the use of a tube instead of a rod.

26.1.2 *For Method B* — A length of approximately 660 mm (recovered in the case of heat shrinkable sleeving) shall be drawn on to a fine-steel wire 0·25 mm in diameter and 900 mm in length. The sleeving shall be closed at the top end to prevent a chimney effect.

26.2 Source of Heat

26.2.1 *Gas Burner* — The burner shall have a nominal bore of 9 $\pm$ 1 mm. For natural gas, a conventional Bunsen burner may be used, the burner being regulated to give a flame approximately 125 mm long with an inner blue cone approximately 40 mm long.

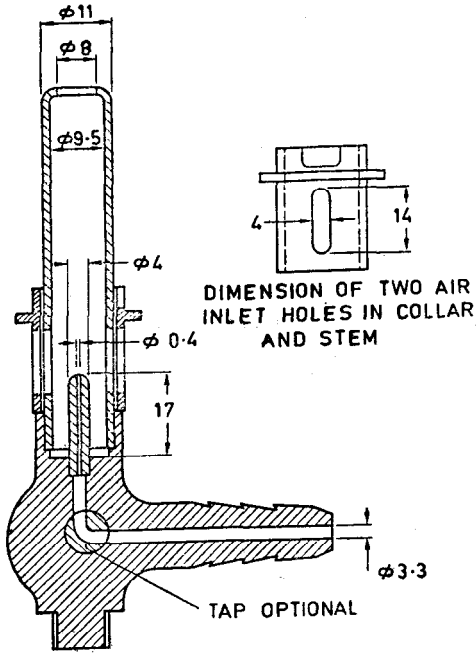
If propane is used, the burner in Fig. 10 shall be used.

It may be convenient for burners to use a small pilot flame.

26.2.2 *Check of Burner Operation* — The satisfactory operation of the burner shall be checked as follows, with the base of the burner being horizontal; a bare copper wire, 0·71 $\pm$ 0·025 mm in a diameter, having a free

*Test method for evaluating resistance to tracking and erosion of electrical insulating materials used under severe ambient conditions.

length of not less than 100 mm shall be inserted horizontally in the flame about 10 mm above the edge of the burner on the side remote from the supported end of the wire. The time required for the wire to melt shall be not more than 6 seconds and not less than 4 seconds.

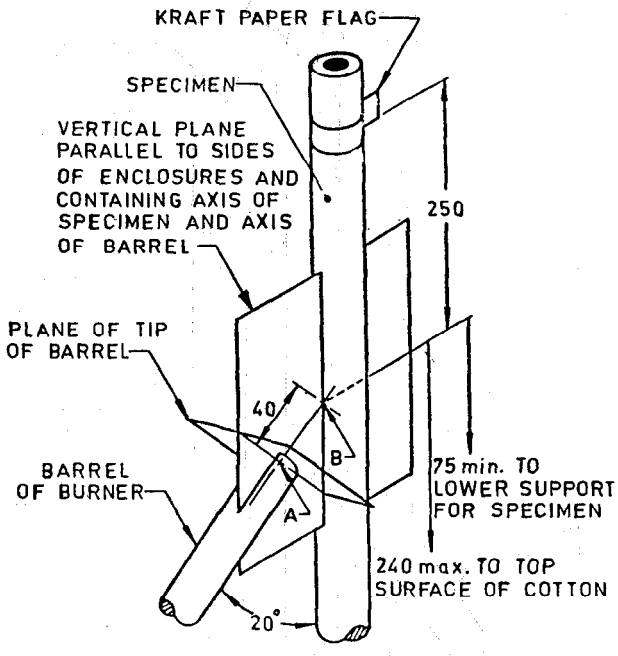


All dimensions in millimetres.

FIG. 10 STANDARD PROPANE BURNER FOR FLAME PROPAGATION TEST (SECTIONAL VIEW)

26.3 Cabinet and Arrangements Within I_t — The test shall be conducted in an exhaust hood or cabinet with the specimen surrounded by a three sided metal enclosure to protect it from draughts. The arrangement of specimen and burner within the cabinet are shown in Fig. 11 for Method A and in Fig. 12 for Method B.

The specimen shall be secured with its longitudinal axis vertical in the centre of the enclosure. For Method B this shall be achieved by securing the specimen to the middle of the upper support by kinking the sleeving



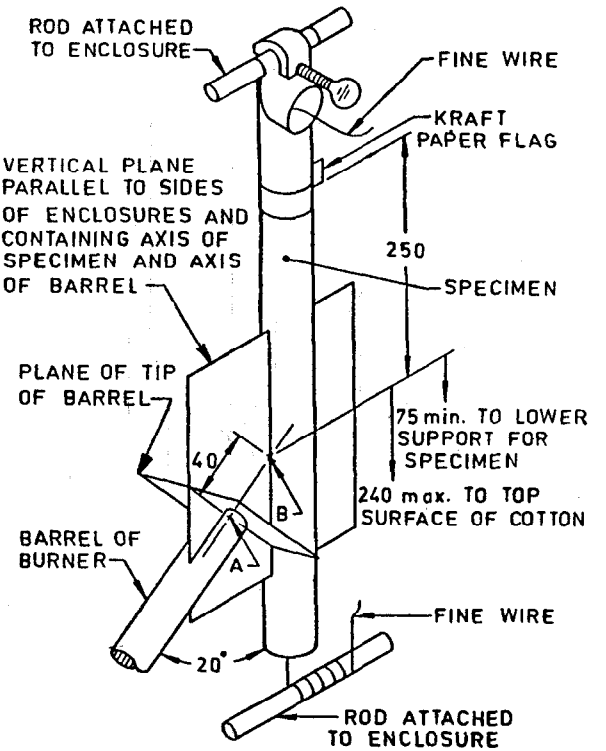
All dimensions in millimetres.

FIG. 11 FLAME PROPAGATION TEST — METHOD A (PROPORTIONS EXAGGERATED FOR CLARITY OF DETAILS)

and clamping (using a paper clip or clamp) to provide a closed end to the specimen thus preventing any chimney effects during the test. The lower end of the wire protruding from the open end of the sleeving shall be anchored, for example, to a support rod as shown in Fig. 12.

A wedge to which the base of the burner can be secured shall be provided for tilting the barrel 20 degrees from the vertical in the same plane as the specimen. The burner shall be secured to the wedge and the assembly placed in an adjustable support jig.

The jig shall be placed with the longitudinal axis of the barrel in the vertical plane that contains the longitudinal axis of the specimen so that the barrel points to the near of the enclosure. The jig shall also be adjusted to position the point *A* 40 mm from the point *B* which is the point at which the tip of the blue inner cone touches the centre of the front of the specimen. The specimen shall be adjusted vertically to prevent



All dimensions in millimetres.

FIG. 12 FLAME PROPAGATION TEST — METHOD B (PROPORTIONS EXAGGERATED FOR CLARITY OF DETAILS)

point *B* from being closer than 75 mm to the lower clamp or other support for the specimen.

A layer of untreated surgical cotton approximately 3 mm thick shall cover the floor of the enclosure including the wedge and base of the burner. The upper surface of the cotton shall be no more than 240 mm below point *B*.

A strip of unreinforced kraft paper (80 to 100 g/m^2) that is 13 mm wide, approximately 0·1 mm thick and is gummed on one side, is to be used to make an indicator flag. The gum shall be moistened just sufficiently to obtain adhesion. With the gum towards the specimen, the strip shall be wrapped around the specimen once with its lower edge 250 mm above

point *B*. The ends of the strip shall be pressed together evenly and trimmed to provide a flag that projects 20 mm from the specimen toward the rear of the enclosure with the flag parallel to the sides of the enclosure (*see* Fig. 11 and 12).

26.4 Procedure — The flame shall be applied to the specimen for 15 seconds removed and reapplied at 15 seconds intervals for a total of five 15 seconds applications of the gas flame to the specimen with 15 seconds between applications. Unless flaming or glowing of the specimen persists longer than 15 seconds after the previous application of the gas flame, in which case gas flame shall not be reapplied until flaming or glowing of the specimen cases of its own accord.

26.5 Result — The following shall be reported:

a) The maximum time in seconds that any specimen continues to flame or glow after any removal of the gas flame.

b) Whether emission of flaming or glowing particles or flaming drops at any time ignite the cotton on the burner, wedge, or floor of the enclosure (flameless charring of the cotton is to be ignored).

c) Whether the indicator flag is burned away or charred on any one of the three tests (soot that can be removed with a cloth or the fingers and brown scorching are to be ignored).

27. FLAMMABILITY — OXYGEN INDEX TEST

27.1 The test shall be carried out in accordance with IS : 10810 (Part ...)* and using the specimens detailed below.

Specimens 70 mm to 150 mm in length shall be cut from the sleeving, the cut edges shall be relatively smooth.

For sleeving of bore larger than that can be accommodated in the apparatus, suitable strips which can be accommodated in the appratus shall be used.

For specimens which are not self-supporting, a length of nichrome or other heat resisting wire, not more than 0·25 mm in diameter, shall be threaded through the sleeving and suitably supported.

28. TRANSPARENCY

28.1 The test specimen shall be approximately 100 mm long and shall be split longitudinally. It shall be immersed in water at 55 ± 1°C for 4 ± 1/4 h. At the end of this period, the test specimen shall be removed,

*Method of tests for cables: Part ... Oxygen index test (*under preparation*).

dried and placed over printed text of type similar to that printed below:

A c k l d e w g y m o

For compliance with this test, it should be possible to read the characters printed above through the specimen of sleeving.

29. IONIC IMPURITIES TESTS

29.1 Conductivity and *p*H values shall be determined on water extracts obtained and measured in accordance with IS : 10581-1983*.

30. SILVER STAINING TEST

30.0 Introduction — In this test, a specimen or specimens of sleevings are placed in contact with silver foil and both are exposed to a temperature of 70°C for 30 min. The darkness of any stain on the silver foil is then compared with that of a strip of film of the 'standard shade' which is part of the 'stain tester'.

30.1 Number and Form of Test Specimens — One or more specimens shall be cut so as to expose a fresh angular surface. The length shall be not less than the wall thickness and short enough for the sleeving to be stable when standing vertically.

30.2 Stain Tester — The stain tester consists of a rectangular piece of photographic film, with a strip exposed so that it darkens to a defined density known as the standard shade. This strip is 3 mm wide and equidistant from each side.

The stain tester shall fulfil the following requirements:

a) The clear photographic film background shall have a visual density, type VI-b, not greater than 0·050.

b) The difference in density between the standard shade and the clear photographic film background shall be 0·015 $\pm$ 0·005.

30.3 Procedure — The test specimen(s) shall be placed with the freshly cut surface downward on a larger piece of analytical silver foil which has been thoroughly cleaned and polished with jeweller's rouge and water and rubbed dry with a clean cloth.

The foil shall be placed with the specimen resting on it, in a suitable air oven and maintained at 70 $\pm$ 2°C for 30 $\pm$ 2 min.

*Methods of test for the determination of ionic impurities in electrical insulating materials by extraction with liquids.

The test specimen shall then be removed from the foil and the silver visually examined for staining. If any stain is observed, it shall be viewed through the clear part of the stain tester adjacent to the standard shade.

30.4 Result — The sleeving is deemed to have passed the test if no part of the stain is darker than the standard shade.

31. ELECTROLYTIC CORROSION RESISTANCE

31.1 Tests shall be made in accordance with one of the methods given in IS : 8516-1977*. The particular method will be specified in Part 3.

32. CORROSION RESISTANCE (TENSILE AND ELONGATION METHOD)

32.0 This test determines the mutual interaction between copper and sleeving.

32.1 Number and Form of Test Specimens — Five specimens, each 150 mm long, shall be slid over straight clean bare copper mandrels which give a snug fit in the sleevings. The mandrel shall normally be a copper tube but for specimens of bore diameter 6 mm or less, the mandrel may be a solid copper rod.

32.2 Procedure — The specimen, while still on the mandrel, shall first be conditioned for 24 h in an atmosphere of 27 $\pm$ 5°C and not less than 90 percent relative humidity. It shall then be transferred to an air-circulating oven and heated at 160 $\pm$ 3°C for 168 $\pm$ 2 h, unless otherwise specified in Part 3 for a particular type of sleeving. After removal from the oven, it shall be allowed to cool.

The specimen shall then be removed from the mandrel (by slitting if necessary) and both the mandrel and specimen examined for signs of chemical interaction, such as adhesion of the sleeving to the mandrel or pitting or corrosion of the mandrel. Mechanical adhesion of the sleeving to the mandrel or darkening of the copper due to normal air oxidation shall be ignored.

The specimen shall then be tested for tensile strength and elongation at break in accordance with **19**.

32.3 Result — The report shall include the central, highest and lowest values for both tensile strength and elongation and whether any specimen or mandrel showed signs of chemical interaction.

*Methods of test for determining electrolytic corrosion with insulating materials.

33. PRESENCE OF CORROSIVE VOLATILES (COPPER MIRROR METHOD)

33.0 This test determines the effect on copper of volatile constituents in sleeving.

33.1 Apparatus

a) Test tubes — 13 × 300 mm;

b) Copper-glass mirror — 6 mm wide × 25 mm long. Store them in a properly conditioned desiccator. The mirrors shall be vacuum deposited copper with a thickness equal to 10 ± 5 percent transmission of normal incident light of 500 mm. Use them for the test only if no oxide film is present and the copper is not visibly damaged;

c) Corks;

d) Aluminium foil;

e) Fine copper wire; and

f) Oil bath capable of maintaining oil temperature to within ±2°C.

33.2 Specimens — Heat shrinkable sleeving shall be tested in the fully recovered state. Specimen size is detailed in the following procedures. One specimen shall be tested.

33.3 Procedure — For sleeving having a diameter (recovered) less than 3 mm, place a 25 mm length of sleeving in the bottom of two clean, dry 13 mm × 300 mm test tubes. For sleeving having a diameter (recovered) of 3 mm and greater, use a 6 mm × 25 mm strip cut longitudinally. Use a third test tube as a control. Suspend a copper-glass mirror as defined above 150 to 180 mm above the bottom of the test tube by means of fine copper wires attached to a cork and ensure that the mirror is vertical. Seal the test tube with the cork wrapped in aluminium foil.

Immerse the lower 50 mm of the test tubes in an oil bath at the temperature and for the time specified in Part 3. Keep the temperature of that portion of the test tube containing the mirror at a temperature below 60°C.

After cooling, examine the mirror by placing it against a white background in good light. Any removal of copper from the mirror will be a sign of corrosion. Disregard any removal of copper from the bottom of the mirror provided the area does not exceed 8 percent of the total area of the mirror since drippings may cause this condition. Do the total not

consider discolouration of the copper film or reduction of its thickness as corrosion. Consider the area over which the removal of copper has made the mirror transparent as the corrosion area. If the mirror in the control tube shows any sign of corrosion the test shall be repeated.

33.4 Result — The result is the total area of corrosion on the two mirrors within tubes containing the specimens exposed as a percentage of the original combined coated area of the two mirrors.

34. COLOUR FASTNESS TO LIGHT

34.0 General – The specimen sleeving and the dyed woolen fastness standard No. 5 specified in IS : 765-1979* shall be exposed to the light from a xenon or enclosed carbon are under equal conditions such that the ambient temperature does not exceed 40°C, with no specific control of humidity.

34.1 Test Specimen – A suitable length of sleeving.

34.2 Procedure – The specimen and the fastness standard shall be exposed to the light source until the change in colour of the exposed part of the fastness standard No. 5 compared with an unexposed standard No. 5 is equal to Grade 4 on the geometric grey scale of IS : 765-1979.*

NOTE — Examine the exposed fastness standard No. 5 frequently to ensure that the prescribed degree of fading is not exceeded.

The exposed specimen shall be compared with the colour as specified in IS : 5831-1978†.

35. RESISTANCE TO OZONE

35.0 Make the test in accordance with Appendix B and the following details.

35.1 Number and Form of Test Specimen — One specimen approximately 25 mm in length shall be tested.

35.2 Procedure — The specimen shall be fitted onto a smooth aluminium mandrel that has a diameter to extend the sleeving by tne amount specified in Part 3.

The mounted sleeving shall be exposed for the period specified in Part 3 to an atmosphere containing 25 $\pm$ 5 m/m^3 of ozone at a temperature of 27 $\pm$ 2°C.

*Methods for determination of colour fastness of textile materials to rubbing.
†Specification for PVC insulation and sheath of electric cables.

After removal from the ozone rich atmosphere the sleeving shall be examined for cracks with normal eyesight.

35.3 Result — To pass the test no cracks shall be visible with normal eyesight.

36. RESISTANCE TO SELECTED FLUIDS

36.0 Introduction — It is necessary to define the following:

a) Choice of fluid,

b) Temperature of immersion,

c) Duration of immersion, and

d) Method of assessment.

36.1 Choice of Fluid — When not specified in Part 3 the fluids shall be agreed between the purchaser and the supplier and the quantity in which the specimens are immersed shall be 4 ml per square centimetre of total specimen surface.

NOTE — Adequate precautions shall be taken to protect personnel from any health or fire hazards resulting from the use of a particular fluid.

36.2 Methods of Assessment

a) Breakdown voltage as in **21**,

b) Tensile strength or elongation at break as in **19**, and

c) Visual examination.

36.3 Number and Form of Test Specimens — The number of test specimen depend on the method of assessment. Specimens shall be selected in accordance with the requirement of **21** or **19** or if visual assessment is used then three specimens, each of 25 mm length, shall be used.

36.4 Procedure — The specimens shall be immersed in the fluid at a temperature of 27 $\pm$ 2°C for 24 $\pm$ 1 unless another temperature or duration is specified in Part 3 for the particular material or unless otherwise agreed between the purchaser and the supplier.

NOTE — Where tensile strength is used for assessment, cross-sectional area shall be determined before immersion.

The specimen shall then be removed from the fluid, allowed to drain and the outside wiped dry lightly. They shall then be tested by one or more of the methods given in **36.2** at ambient temperature.

36.5 Test Result — The result is that appropriate to the method of assessment chosen and shall be described as required by **21** or **19**. The result may be related to a fixed requirement value or else to a percentage degradation from results on specimens which have not been subjected to immersion.

If visual assessment is being used or is required in addition, any tendency for the specimens to show deterioration such as swelling, tackiness crumbling, splitting or blistering immediately after removal from the fluid shall be reported.

37. THERMAL ENDURANCE

37.1 This test is to be made in accordance with IS : 8504 (Part 1) - 1977*.

The particular test procedure and end points to be used are given in Part 3.

38. RESISTANCE TO WEATHER

38.1 Number of Test Specimens — Five specimens shall be tested.

38.2 Form of Test Specimen — As appropriate for the end point tests, that is tensile strength and elongation (as per **19**) and breakdown voltage (as per **21**).

38.3 Procedure — The test shall be conducted in a weather simulator and shall be for not less than 5 000 h.

The weather simulator shall include the following features:

a) Ultra-violet light source of the xenon arc type with an input power not less than 5 kW arranged at a distance from the specimens not exceeding 500 mm.

b) The atmospheric conditions to include the introduction, distribution and control of ozone gas and sulphur dioxide gas under variable temperature conditions, and a cold water spray.

The weather simulator 24 h cycle shall be:

1) 102 min of ultra-violet light exposure;

2) 18 min of ultra-violet light exposure with water spray;

3) Items (1) and (2) repeated nine more times; and

4) 6 h period of darkness without water spray.

*Guide for determination of thermal endurance properties of electrical insulating materials: Part 1 Temperature indices and thermal endurance profile.

During the tests, the following atmospheric conditions shall apply:

Ozone concentration	20 pphm
Sulphur dioxide concentration	20 pphm
Temperature when arc is ON	50°C
Temperature when arc is OFF	25°C
Relative humidity when arc is ON	50 percent
Relative humidity when arc is OFF	98 percent
Water spray temperature	20°C

The conditions shall be controlled within ± 2 percent and the temperature within ± 2°C of the stated values.

At the end of the required period, the specimens shall be removed and visually examined for the degree of surface deterioration, then subjected to the following tests:

Elongation test (*see* **19**)

Tensile strength (*see* **19**)

Breakdown voltage (*see* **21**).

APPENDIX A

(*Clause* 11.3)

DETERMINATION OF THE THERMAL STABILITY OF POLYVINYL CHLORIDE AND RELATED COPOLYMERS AND THEIR COMPOUNDS BY SPLITTING OFF OF HYDROGEN CHLORIDE

A-1. Two methods for the determination of thermal stability of polyvinyl chloride and related copolymers and their compounds in general are recommeded:

a) the Congo red method; and

b) the *p*H method.

Each of these two methods allows determination of the thermal stability with regard to splitting off of hydrogen chloride from polyvinyl chloride (PVC) and from chlorinated polymers and copolymers and their compounds in general when they are brought to a high temperature for extruding, moulding, calendering or other processing.

The Congo red method is simple and rapid, but give one value only and the attention of an observer is required. The *p*H method permits the use of recording equipment and gives more information.

A-2. Thermal stability or thermal life of a compound of vinyl chloride polymers or copolymers means the time, in minutes, from the moment at which the material is exposed to a given temperature in a given atmosphere until the first sign of decomposition is observed. The mode of decomposition is based on the splitting off of hydrogen chloride.

A-3. PRINCIPLE

A-3.1 Congo Red Method — Heating of the test portion, in still air, to the test temperature recommended for the material under test.

Measurement of the time required until the hydrogen chloride split off results in a colour change from red to blue of Congo red paper placed above the test portion.

A-3.2 *p*H Method — Heating of the test portion, in a moving gas medium, to the test temperature recommended for the material under test; the hydrogen chloride split off is collected in a *p*H measuring cell.

Measurement of the time required until the hydrogen chloride split off results in a decrease of *p*H to a value corresponding to that at which Congo red paper changes colour from red to blue.

NOTE 1— Air is a suitable gas if the process of interest implies oxidation, for example, milling or calendering. On the other hand, if oxidation is essentially excluded by the process, as in extrusion, an inert gas such as nitrogen may be used.

NOTE 2 — The chief difference between the two methods is the fact that the measurement is made in still air in the Congo red method and in a moving gas medium, which need not necessarily be air, in the *p*H method.

A-4. SIGNIFICANCE OF TEST

A-4.1 The thermal decomposition of PVC is a very complex reaction which, in compounds, is greatly affected by the type and quantity of the stabilizers, other additives, and the gas medium. The decomposition which takes place with the splitting off of hydrogen chloride and with the change in colour and appearance may result in the partial or complete charring of the material.

The splitting off of hydrogen chloride is one of the most important signs of the decomposition of PVC, even if it does not proceed along parallel lines with the discoloration and with other degradation phenomena

A-4.2 While the Congo red method gives one value only. The *p*H method provides information on the induction period of the thermal decomposition leading to splitting off of hydrogen chloride under the influence of air or another gas medium. It also gives information on part of the further decomposition process.

A-5. TEST PORTIONS

A-5.1 Congo Red Method — Enough material is placed in each test tube to fill it to a depth of 50 mm.

A-5.2 *p*H Method — In accordance with Appendix B of IS : 5831-1984*.

A-6. APPARATUS AND MATERIALS

A-6.0 The following apparatus and meterials are required.

A-6.1 Timing device, calibrated in minutes.

A-6.2 Oil-bath, fitted with stirrer and thermostatic control, capable of maintaining the temperature within ± 1°C in the range from 120 to 210°C. The bath should have a thermoshield at the top and should be fitted with clamps capable of holding a sufficient number of test tubes immersed to a depth of 50 mm.

NOTE — Baths with triethylene glycol as heating liquid are also satisfactory. A metal block and other heating devices can also be employed, provided they comply with the requirements of **A-6.2**.

A-6.3 Flat bottomed test tube, having the following dimensions:

External diameter, approximately	17 mm
Wall thickness	0·4 mm
Length, minimum	150 mm

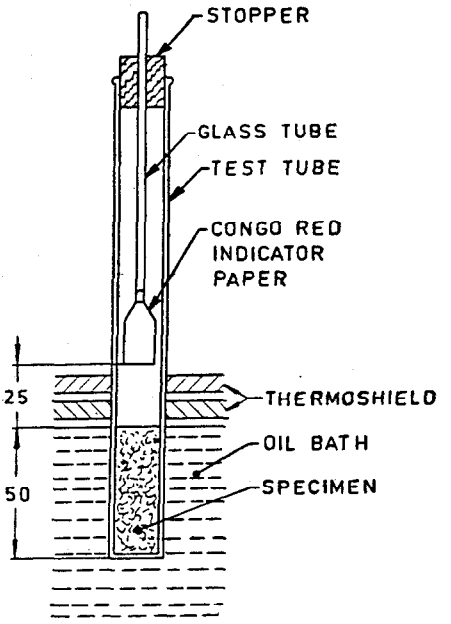
Stoppers are required, with provision for the glass tubes and cells described in **6.4**.

A-6.4 Glass tubes, as follows:

A — Congo red method — Small glass tubes, 2 to 3 mm in internal diameter and about 100 mm in length (*see* Fig. 13).

B — *p*H Method — In accordance with Appendix B of IS : 5831-1984*

*PVC insulation and sheath of electric cables.



All dimensions in millimetres.

FIG. 13 TEST TUBE PREPARED FOR PROCEDURE A

A-6.5 Congo Red Method — Congo red indicator strips, 10 mm wide. The indicator paper is prepared by immersing strips of filter in 0·15 percent solution of Congo red in methanol, and drying.

A-6.6 *p*H Method — In accordance with IS : 5831-1984*.

A-7. PROCEDURE A — CONGO RED METHOD

A-7.1 Place the material to be tested in the test tube and gently shake it down, taking care to ensure that the pieces do not form a compact mass.

A-7.2 Close the test tube with a stopper having at its centre the glass tube with a Congo red paper strip 30 mm long and 10 mm wide. The Congo red strip is folded or rolled at one end, which is inserted into the glass

*PVC insulation and sheath of electric cables.

tube. The tube is made to slide in such a way that the lower edge of the paper will be placed 25 mm above the top of the specimen.

A-7.3 Immerse the test tube thus prepared in the oil-bath — which is already brought to the given temperature — to the level of the upper surface of the test portion.

A-7.4 For each sample, at least two determinations should be carried out, in two separate test tubes, which are immersed in the oil-bath at the same time.

A-7.5 The preferred temperature is 180 ± 1°C. Other temperature may be used, provided that the duration of the test is not less than 20 minutes and not more than 5 hours.

NOTE — A temperature of 200°C is recommended for particularly stable materials and a te mperature of 170°C for less stable materials. The test temperature should be selected according to the processing conditions employed for the material. Thus, rigid PVC which is processed by injection moulding or extrusion should be tested at 200°C in an inert gas. On the other hand, a material should be tested at 170°C in air if it is proccessed on a roll mill or calender. Adhere nce to the test temperature recommended is advisable in order to simplify the experimental operations and to provide a satisfactory basis for a comparison of the results. The recommended test temperature cannot be employed in all cases. Thus, much lower temperature are necessary for a number of copolymers in order to simulate the conditions employed in processing the material.

A-7.6 The time, in minutes, for the two values determined from the insertion of the test tube in the hot oil to the time when the indicator paper shows the first clear signs of a change from red to blue, is recorded. When two values are more than ±10 percent apart from their average, the test should be repeated.

A-7.7 Sometimes, with certain stabilizers, the colour change is only slow and not very distinct; in these cases, two different times should be recorded, corresponding both to the first sign of colour changing from red to violet and to the permanent change from violet to blue.

A-8. PROCEDURE B — *p*H METHOD

A-8.1 It shall be in accordance with Appendix B of IS : 5831-1984*

A-9. EXPRESSION OF RESULTS

A-9.1 The thermal stability is expressed by the time, in minutes, from the immersion of the tube containing the test portion in the oil-bath until either the indicator paper shows a change in colour (method A) or a *p*H of 3·9 ± 0·1, or other specified value (method B), is reached.

*PVC insulation and sheath of electric cables.

A-10. TEST REPORT

A-10.1 The test report should give the following information:

a) Method used;

b) The complete identification of the material tested and, if desired, the formulation of the compound and the thermal treatment during the preparation of the test specimens;

c) Test temperature;

d) *p*H method only: nature of the gas medium and temperature of the solution in the measuring cell;

e) The results obtained; in the case of slow changing in colour when the Congo red method is used, the two times obtained according to **7.7** should be recorded; and

f) Date of test.

APPENDIX B

(*Clause* 35.0)

RUBBER, VULCANIZED — RESISTANCE TO OZONE CRACKING — STATIC STRAIN TEST

B-1. This method is intended for use in estimating the resistance of vulcanized rubbers to cracking when exposed, under static tensile strain, to air containing a definite concentration of ozone and at a definite temperature in circumstances where the effects of direct light are excluded.

B-2. APPARATUS

B-2.1 Test Chamber — This shall be a closed, non-illuminated chamber, thermostatically controlled to within $\pm 2°C$ of the test temperature, lined with, or constructed of, a material (for example, aluminum) that does not readily decompose ozone.

The chamber may be provided with a window through which the surface of the test pieces can be observed.

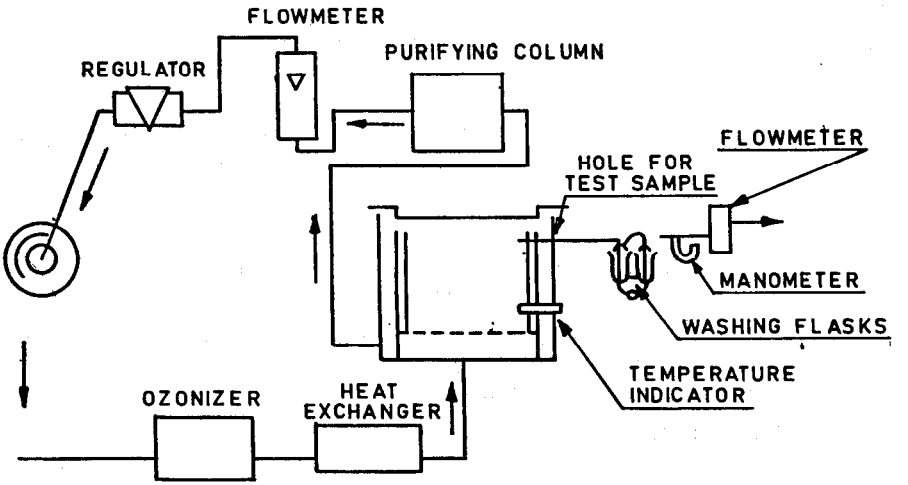


FIG. 14 SCHEMATIC DIAGRAM OF THE APPARATUS

B-2.2 Source of Ozonized Air — Either of the following apparatus may be used:

a) an ultra-violet lamp; and

b) a silent discharge tube.

The use of oxygen is necessary when using the discharge tube in order to avoid the formation of nitrogen oxides. The ozonized oxygen or air may be diluted with air to attain the required ozone concentration. Air used for generation of ozone or dilution shall first be purified by passing it over activated charcoal and shall be free from any contaminants likely to affect the ozone concentration, cracking or estimation of ozone.

The temperature of the source shall be kept constant to within $\pm 2°C$.

The ozonized air shall be fed from the source into the chamber via a heat exchanger to adjust its temparature to that required for the test and shall be brought to the specified relative humidity (*see* **B-3**).

B-2.3 Test Piece Carrier — Clamps shall be provided for holding the test pieces at the required elongation with both sides in contact with the ozonized air in such a manner that the length of the test piece is substantially parallel to the gas flow. The clamps shall be made of material which does not readily decompose ozone (for example, aluminium).

The use of a mechanically rotating carrier mounted in the test chamber and upon which the clamps or frames for holding the test pieces are mounted is recommended to equalize the effect of different ozone concentration in the chamber. In one example of a suitable carrier, the test pieces move at a speed between 20 to 25 mm/s in a plane normal to the gas flow and each follow consecutively the same path in such a manner that the same position within the chamber is visited by the same piece every 8 to 12 min, and the area swept by the piece is at least 40 percent of the available cross-sectional area of the chamber.

B-3. TEST CONDITIONS

B-3.1 Ozone Concentration — Unless otherwise specified, the test shall be carried out at an ozone concentration of 50 ± 5 parts per hundred million by volume (pphm). If a lower concentration is required for testing rubbers known to be used under low ambient ozone concentrations, an ozone concentration of 25 ± 5 pphm is recommended. If highly resistant polymers are being tested, a test concentration of 200 ± 20 pphm is recommended.

NOTE — It has been found that differences in atmospheric pressure can influence ozone cracking when test pieces are exposed to constant ozone concentrations expressed in parts per hundred million. This effect may be taken into account by expressing the ozone content in the ozonized air in terms of the partial pressure of ozone, that is in millipascals, and making comparisons at constant ozone partial pressures. At standard conditions of atmospheric pressure and temperature (101 kPa, 273 K) a concentration of 1 pphm is equivalent to a partial pressure of 1·01 MPa.

B-3.2 Temperature — The preferred temperature of test shall be 40 ± 2°C. Other temperatures such as 30 ± 2°C or 23 ± 2°C may be used but the results obtained will differ from those obtained at 40 ± 2°C.

B-3.3 Relative Humidity — The relative humidity of the ozonized air should not normally be more than 65 percent at the test temperature.

Very high humidity can influence the results; for products intended for use in damp climates, the test shall be carried out at a relative humidity in the range 80 percent to 90 percent.

B-3.4 Elongation — Tests should normally be carried out with test pieces stretched to one or more of the following elongations:

5 ± 1 — 10 ± 1 — 15 ± 2

20 ± 2 — 30 ± 2 — 40 ± 2

50 ± 2 — 60 ± 2 — 80 ± 2 percent.

B-4. TEST PROCEDURE

B-4.1 Adjust the rate of flow and temperature of the ozonized gas and its ozone concentration to that required and place the strained test pieces, in the test chamber. Maintain the test conditions at the required levels.

Periodically examine the test pieces for the development of cracking by means of lens of magnification about 7X, the test pieces being illuminated at the time of examination by a suitably arranged light source. The lens may either be mounted in a window in the chamber wall, or the test pieces may be removed from the chamber for a short period, in their clamps. The test pieces shall not be handled or bumped when carrying out the examination.

NOTE 1 — Attention is drawn to the highly toxic nature of ozone. Appropriate measured should be taken to minimize the exposure of the operator.

NOTE 2 — Cracking on surfaces which have been cut or buffed shall be ignored.

Three alternative procedures for exposure of test are permissible.

B-4.2 Procedure A — Strain the test pieces at 20 percent elongation and examine them after 72 h for the development of cracking. An alternative elongation and an exposure period may be given in the appropriate material specification.

B-4.3 Procedure B — Strain the test pieces at one or more of the elongations given in **B-3.4.** If only one elongation is used, this shall be 20 percent unless otherwise specified. Examine the test pieces after, 2, 4, 8, 16, 24 48, 72 and 96 h and, if necessary, at suitable intervals therafter and note the time until the first appearance of cracks at each elongation.

B-4.4 Procedure C — Strain the pieces at no fewer than four of the elongation given in **B-3.4.** Examine the test pieces after 2, 4, 8, 16, 24, 48, 72 and 96 h and, if necessary, at suitable intervals thereafter and note the time until the first appearance of cracks at each elongation, so that the threshold strain can be estimated.

NOTE — For procedures B and C it is sometimes satisfactory to omit examination at 16 h.

B-5. EXPRESSION OF RESULTS

B-5.1 Procedure A — Report the results as no cracking or cracking. If cracking has occurred and an estimate of the degree of cracking is required, a description of the cracks (for example, appearance of single cracks, the number of cracks per unit area and the average length of the ten largest cracks) may be given, or a photograph of the cracked test piece may be taken.

B-5.2 Procedure B — Take the time to the first appearance of cracks as the measure of ozone resistance at the specified strain.

B-5.3 Procedure C — Indicate the range within which the threshold strain is found to lie by reporting the highest strain at which cracking was not detected and the lowest strain at which cracking was observed after the specified exposure period. If replicate tests give different results quote the extreme range observed, for example, if three test pieces are used at each of 10, 15 and 20 percent strains and one cracks at 10 percent only, one at 15 percent and all three at 20 percent, the quoted range should be 10 to 20 percent. Graphical presentation may be used to assist interpretation of the results.

NOTE 1 — A method that has been found useful is to plot the logarithm of strain against the logarithm of the time to first cracking — both the longest time at which no cracks are seen and the earliest time when cracks are observed may be plotted. Where possible, a smooth curve may be drawn taking into account the gap between the longest time with no cracks and the earliest time with cracks at each strain to assist estimation of the threshold strain for any time within the test period (*see* Fig. 3). For some rubbers the curve may approximate to a straight line but this should not be assumed since it can lead to large errors in estimating threshold strain. Unless otherwise specified, the threshold strain at the longest test period should be reported.

NOTE 2 — With some rubbers, a linear plot of strain against time to first cracking will enable the existance of a limiting threshold strain to be observed.

B-6. TEST REPORT

B-6.1 The test report shall contain the following information:

a) *Sample Details*

1) a full description of the samples and its origin;

2) compound details, cure-time and temperature, where appropriate; and

3) method of preparation of test pieces, for example, whether moulded or cut.

b) *Test Method*

1) the reference of this Indian Standard;

2) the procedure used (A, B or C);

3) the test piece dimensions; and

4) whether a rotating carrier was used.

c) *Test Details*

1) the ozone concentration and the method of estimation;
2) the temperature of test;
3) the temperature of conditioning, if other than the standard laboratory temperature;
4) the humidity, if other than specified;
5) the air flow rate;
6) the strain(s) on the test pieces;
7) the duration of the test; and
8) any non-standard procedure.

d) *Test Results*

1) the number of the test pieces tested at each strain;
2) for procedure A only, whether cracking occurred. If required the nature of cracking may also be given;
3) for procedure B only, the times to the first appearance of cracks; and
4) for procedure C only, the observed range of threshold strain for a suitable exposure period or periods, or the limiting threshold strain.

e) *The Date of Test.*